THE ROOSEVELT DAM AND THE SALT RIVER PROJECT, IN ARIZONA.

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The great Roosevelt Dam, located on the Salt River, at the confluence of Tonto Creek, near the lofty peaks of the Sierra Anchas, constructed under the provisions of the reclamation act of June 17, 1902, was dedicated by Col. Theodore Roosevelt on March 18, 1911. The Salt River reservoir site is 76 miles due east of Phoenix, which is situated in the center of a fertile valley, the greater portion of the region under irrigation being signed up to the Salt River Valley Water Users' Association. This corporation represents the farmers of the Salt River Valley in their dealings with the Government, they guaranteeing the payment of the cost of construction.

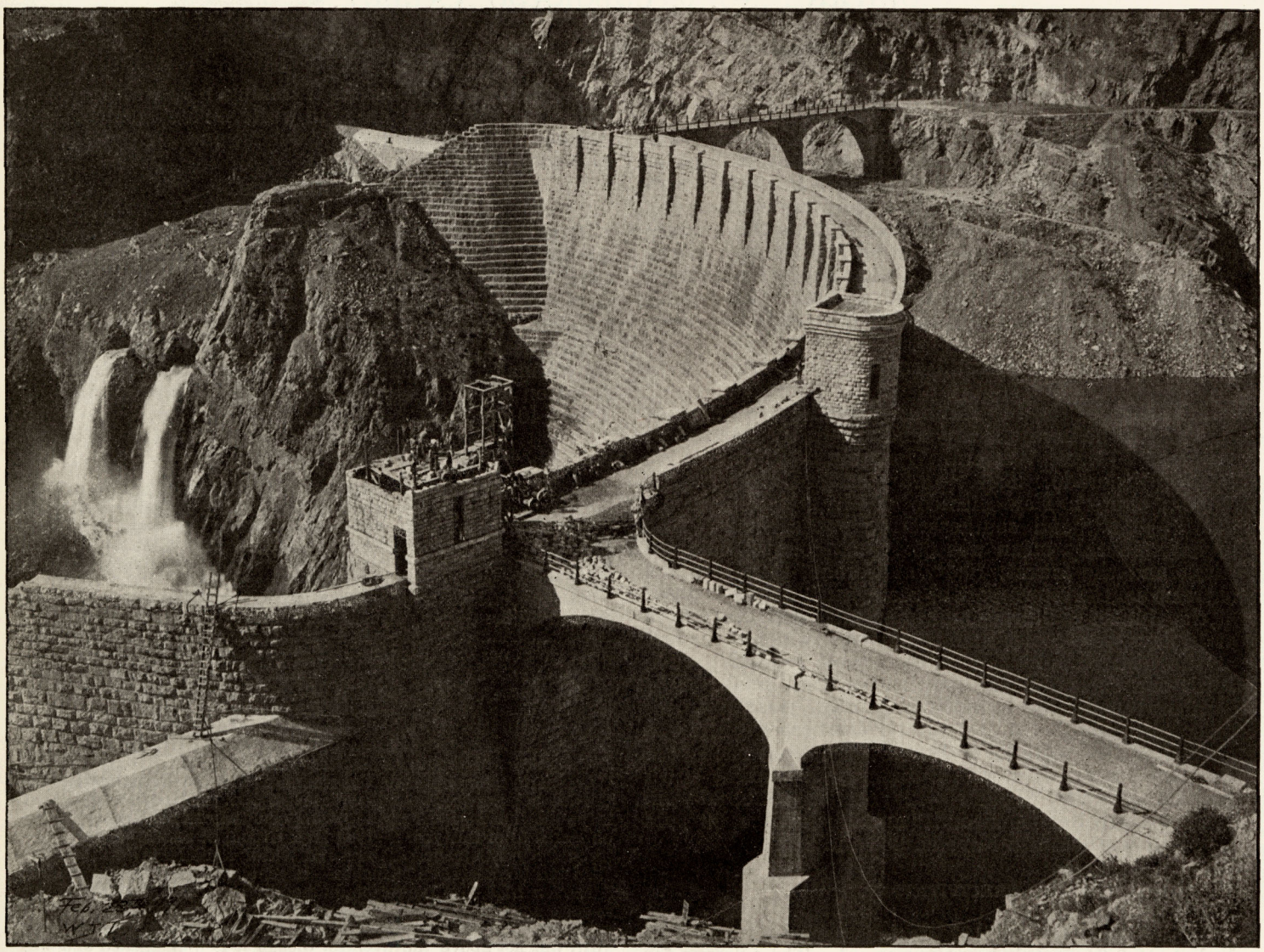

FIG. 1.—Roosevelt Dam.

The impounding of the waters from the upper Salt River and Tonto Creek drainage areas in this natural basin creates a reservoir 25 miles in length and from 1 to 3 miles in width.

According to facts and figures obtained from Mr. L. C. Hill, supervising engineer, United States Reclamation Service, the Republican, and the Arizona Magazine, Phoenix, Ariz., we learn that the capacity of the reservoir is 1,284,205 acre-feet. The foundation of this great pile of masonry rests in bedrock, 40 feet below datum, or river level. At the base it is 235 feet long, between the canyon walls, and 170 feet wide. From the river level to the crest of the spillway, at both ends of the dam, the height is 220 feet, that being the greatest depth of possible storage. The spillways are bridged, and over the bridges and the top of the dam runs the only highway in that region connecting the mountain country on the north and south sides of Salt River. This roadway is 20 feet above the highest storage and is protected by a coping 4 feet high; thus making the distance from the bottom of the foundation to the top stone of the coping 284 feet.

The general appearance of the dam is curved, arching upstream, and at the top is 680 feet long and 16 feet wide, so that the length, inclusive of the bridges over the spillways, is 1,080 feet. The spillways are blasted from the mountain sides, and the bridges over them angle a little upstream from the ends of the dam.

In the work of construction 339,400 cubic yards of masonry were used, every stone of which was thoroughly washed before it was permanently cemented in place.

In the building of the dam and auxiliary works 338,452 barrels of cement were used, all manufactured in the immediate vicinity of the dam, at a cost of $1,063,542.36, in a cement mill erected by the Government. The cost was $3.14 per barrel, as against $4.89 per barrel, the best private bid available when operations began. The manufacture of cement on the ground effected a saving of $592,300, or $2.50 per acre for each acre signed to the Salt River Valley Water Users' Association.

The dam was constructed by John M. O'Rourke & Co., of Galveston, Tex., to whom the contract was awarded on April 8, 1905. The first stone was laid in the foundation September 20, 1906; the last stone was laid on the coping on February 6, 1911. The upper face of the dam is almost perpendicular. The lower face retreats in pyramidal form, huge stone steps, from a width of 170 feet at the foundation to 16 feet at the top.

AUXILIARY WORKS.

No less interesting are the auxiliary and corelated works, such as the cement mill, the hydroelectric plants for generating 8,000 horsepower, and what is termed the power canal, built to operate the first unit of the electric plant, creating power for dam construction. The power canal is a ditch, heading at the intake dam, which diverts water from the Salt River, 19½ miles above Roosevelt, and skirting the high line of the reservoir, reaches the Roosevelt Dam site on the mountain side at about the same elevation as the top of the Roosevelt Dam.

INTAKE DAM AND POWER CANAL.

The intake dam was built exclusively to serve the power canal, and with it was among the first features of the project given attention. As mentioned, it is 400 feet long, with gates and diversion works at the south end, all built of concrete, although the dam is a little higher than is necessary to divert the normal flow of the river. The power canal is somewhat circuitous, following the high line of the reservoir, and in its 19½ miles it crosses two immense arroyas, or ducks under them by means of concrete siphons that were in themselves interesting engineering problems.

ROOSEVELT POWER HOUSE.

The power house is an immense stone structure, so large in fact that it would look like a business block if located in a city. It stands just below the huge dam, from the top of which one looks down upon its large flat roof. Within are the turbines fed through an immense penstock of steel, running through the dam about halfway up its side and controlled by gates. Another building of similar size and appearance stands several hundred yards down the canyon containing the machinery for transforming the current, being the reservoir terminus of the large power line that carries it westward to Phoenix, Mesa, Tempe, and Sacaton for commercial use.

DISCHARGE OF WATER.

Skirting the north end of the dam, almost under the spillway, and driven through solid rock, is Tunnel No. 2, which is 115 feet above the river bed. Its sole mission is for releasing irrigation water when the reservoir shall contain a certain depth above that elevation, and when it is desired to release a greater quantity than will come through the constantly running penstock supplying the power house.

The third exit for stored water, one that is most necessary but will be least used, and the largest of all, is known as the sluicing tunnel, or tunnel No. 1. It was driven through the solid mountain circling the south end of the site, at the river level, before the construction of the dam began. It will be used for sluicing silt, if necessary, and for releasing a larger irrigation supply than the penstock furnishes, if needed, when the water elevation in the reservoir is below the entrance to tunnel No. 2.

ROOSEVELT ROAD.

Among the earliest construction features was the building of a freight road, 60 miles long, from Mesa City, the nearest available railroad point, to the Roosevelt Dam site. Of this, 22 miles is across a desert and 38 miles through the most impressive mountain scenery in the West. The road was constructed for permanency, and though crooked and often winding around the face of cliffs it is as fine a thoroughfare as a city street. The road cost $206,000, of which amount Phoenix and Mesa contributed $71,000, recognizing its commercial value to the valley, rather than have a road constructed to the dam site from Globe, the nearest railroad point in another direction, and which offered almost unsurmountable engineering difficulties in the matter of road building on the Gila-Salt divide. The sum of $147,000 has been spent in betterment and maintenance, making the total cost of this permanent and now famous scenic highway $353,000. Over this road all of the machinery, oil, and other supplies used in the construction of the dam were hauled by mule teams, and it is to-day a perfect mountain boulevard. Since the construction of the Roosevelt Road the Territory has undertaken, and in large part constructed, a system of Territorial highways, to cross Arizona north and south and east and west. The Roosevelt Road has been utilized as a very important section of the east and west highway.

GOVERNMENT SAWMILL.

Not only was the upper Salt River drawn upon for a construction resource through the intake dam and power canal, but the upper Tonto Creek, the mouth of which forms the other arm of the reservoir, contributed its portion. A vast amount of lumber was needed for the building of the cement mill, the houses necessary in the engineering camp, and for multifarious purposes, before the laying of the masonry could begin. Tonto Creek winds back into the pine-clad forests of the Sierra Ancha Mountains, where, 30 miles northeast of Roosevelt, the Government erected a sawmill and built a fine mountain road leading to it. In the early days of the project 3,000,000 feet of lumber was sawed in this mill and brought to the dam site over the new Government road, for the most part down grade. The mill, like the other plants that served their day, was disposed of to the best advantage.

OLD TOWN OF ROOSEVELT.

From the very beginning there was need of many laborers at the dam site and in the auxiliary works. These made their abiding places in shacks, on a bench of the river bank now submerged. Their presence drew

tradesmen, restaurants, and markets, with a better class of buildings, but all of lumber, for it was known in advance of its building that it would be a doomed town. A post office was established and the town grew until it became a village of several hundred inhabitants, with a considerable social life, apart from the engineering camp on the hill. When the dam reached a greater height above datum the hour of danger was announced, and there was a hasty moving of houses to the new and present town site on the flat around the mountain above the dam

DISTRIBUTION OF WATER.

The distributing system is no less interesting than the storage project, though no single feature is so great. Its devising was not attended by so many engineering feats, but was beset by a much more numerous array of perplexing and irritating questions of legality, justice, economy, and feasibility.

When the reclamation act was passed there were in operation in the Salt River Valley, on both sides of the river, no fewer than 11 main canal systems, of private ownership, dealing with the farmers by various plans and holding diversion rights from the river of varying priority. Some of the owners of the canals sold the water direct, and were cooperative, while others sold water rights which the water user must own before buying the water. The water rights were regarded as of value in themselves, whether the owners possessed land or not. A few general principles were enunciated by the reclamation law which had to be complied with, one of these provisions being that the water is a part and parcel of the land. Another, a policy of the administration, was outlined by the Secretary of the Interior, namely, that the Government could not deal with each individual farmer, for obvious reasons. The farmers were advised to form an organization that could represent them all, settle their differences as to priorities, and present a plan by which the Government could deal with them as a whole, and be assured of the certainty of the repayment of the cost of construction.

This led to the formation of the Salt River Water Users' Association upon a plan outlined by Judge Joseph H. Kibbey and Mr. B. A. Fowler. The organization was the work of many months of untiring effort. Then came the question of settling priorities, which was accomplished by the filing of a friendly law suit in the name of one of the oldest water users against every other water user in the Salt River Valley, the court decision to be a record of the priority right of every acre then in cultivation. This suit lasted for three years, and, after the accumulation of much testimony, was finally settled by a decision rendered by Judge Edward Kent, in March, 1910. It was accomplished in a friendly way by an education of public sentiment, in accordance with a theory advanced by Judge Kibbey that there are two occasions when a water right is of no value. One is when there is water for nobody, the other when there is water for all who want it. The first condition frequently faced a large percentage of the farmers, the second condition was to be brought about by water storage. It was that argument, coupled with the assurance of greater value to their lands through the prosperity of a populous community, that induced the "prior righters" to submit to the cost of storage for the benefit of all. Under this plan each acre participating in reservoir privileges is mortgaged to the association to pay its proportionate cost of the project, the association in turn being bound to the Government by contract.

OLD CANALS BOUGHT.

In the meantime the question of building new canals or buying and remodeling the old ones came up, and has been settled by the latter plan, all of the original canals having been bought by the Government, with money charged to the project, except the Tempe system and a part of the Utah Canal. The north side systems were bought first, several years ago, on what was considered fair valuations, the Government paying what it would have cost to parallel them. The main canal on the north side was, and still is, known as the Arizona Canal. It was the largest and the longest and headed at the extreme eastern end of the valley, its head being nearest to the dam site from which the stored water, when released, would course westerly down the river channel some 55 miles to the canal head. The other north side canals were then, and still are, served through the Arizona Canal by a crosscut canal some 15 miles below its head. Most of the south side canals had separate heads, to which water was diverted by means of brush dams.

GRANITE REEF DIVERSION DAM.

The Granite Reef Dam, built mainly for the purpose of diverting the flood waters from the Verde River and the stored water from the Roosevelt reservoir into the canals, is located 28 miles up the Salt River from Phoenix. It is a weir dam of concrete construction, 1,000 feet long between the diversion works on either side, and 38 feet high where the river channel is deepest. The cost was approximately $500,000. From the south end of the dam a new waterway known as the South Canal was constructed as the main artery for serving water to all of the South Canals. In its course, before it reaches any of the distributing canals, is a steep drop which will be the site of a power plant soon to be built.

NEW CROSSCUT CANAL.

The perfection of the distributing system will involve the elimination of many needless small ditches through the construction of larger laterals, the more general use of meters and of cement and concrete in ditches and headings, and one large feature of the project, the construction of a new crosscut canal. The wisdom of its construction lies mainly in the fact that the present canal is not large enough. Another reason is, that by building a new canal, a drop of many feet is assured at one point in its course, making practicable the erection of a hydroelectric power plant that will develop many hundred horsepower, the energy to be used in pumping the underground flow at various points and sold for commercial purposes, returning a notable revenue to the project.

PUMPING PLANTS.

Below the surface of the valley, at depths varying from 10 to 200 feet, is a vast underground flow of water. One of the notable features of the project is the development of hydroelectric power at the Roosevelt Dam and its various drops on the canals, at a cost of little more than the plant installation, its transmission by wire to points where the underground flow is nearest the surface, where it will be applied to pumps for raising the underground flow, and thus augmenting the irrigating water supply. Two pumping plants are now in operation and others will soon be installed, and there are besides several large private plants operated with power generated at the Roosevelt Dam.

COST OF PROJECT.

The allotment of funds for the Salt River project has thus far been about $9,000,000. This includes the disbursements made for the purchase of the old canal systems, though had these not been bought approximately the same amount would have been spent for new ditches. To fully complete the project may cost well toward two millions more. For the 240,000 acres the project when completed should be able to water the expense of construction will, therefore, be about $46 per acre, to be paid in ten equal annual payments. This may seem to the eastern farmer, who is accustomed to a single crop per year from his acres, as an embarrassing price to pay, in addition to the original cost of the land. Such readers should recall that, where they secure one crop a year, the land in this valley is working almost constantly, returning several harvests from some single crops, or two or three by the rotation of others. Again, it should be remembered that with the storage reservoir there is assurance of crops every year, which is more than can be said for the best nonirrigation farming country in other sections.

STORED WATER SUPPLY.

On January 1, 1911, the depth of the stored water supply in the Roosevelt Dam was 61.75 feet, or an equivalent of 22,094 acre-feet; February 1, 1911, depth 109.55 feet, or 147,255 acre-feet; March 1, 1911, depth 126.30 feet, or 300,605 acre-feet; April 1, 1911, depth 166.50 feet, or 561,024 acre-feet.

The warm rains of January 10, 1911, in addition to the rapidly melting snow, yielded about 48 feet of storage water in the Roosevelt Dam. The heavy precipitation in the upper Salt River watershed during February 3–4, 1911, resulted in a run-off of about 17 feet. During the heavy precipitation of March 3, 4, and 5 the drainage from the upper Salt River added a depth of 25 feet. There was an additional depth of about 10 feet during the latter part of March.

It is estimated that should there be no precipitation at all in the catchment basin draining into the Roosevelt Dam for the next year and a half to come there would be more than enough storage water in the dam to irrigate the entire Salt River Valley for that period.

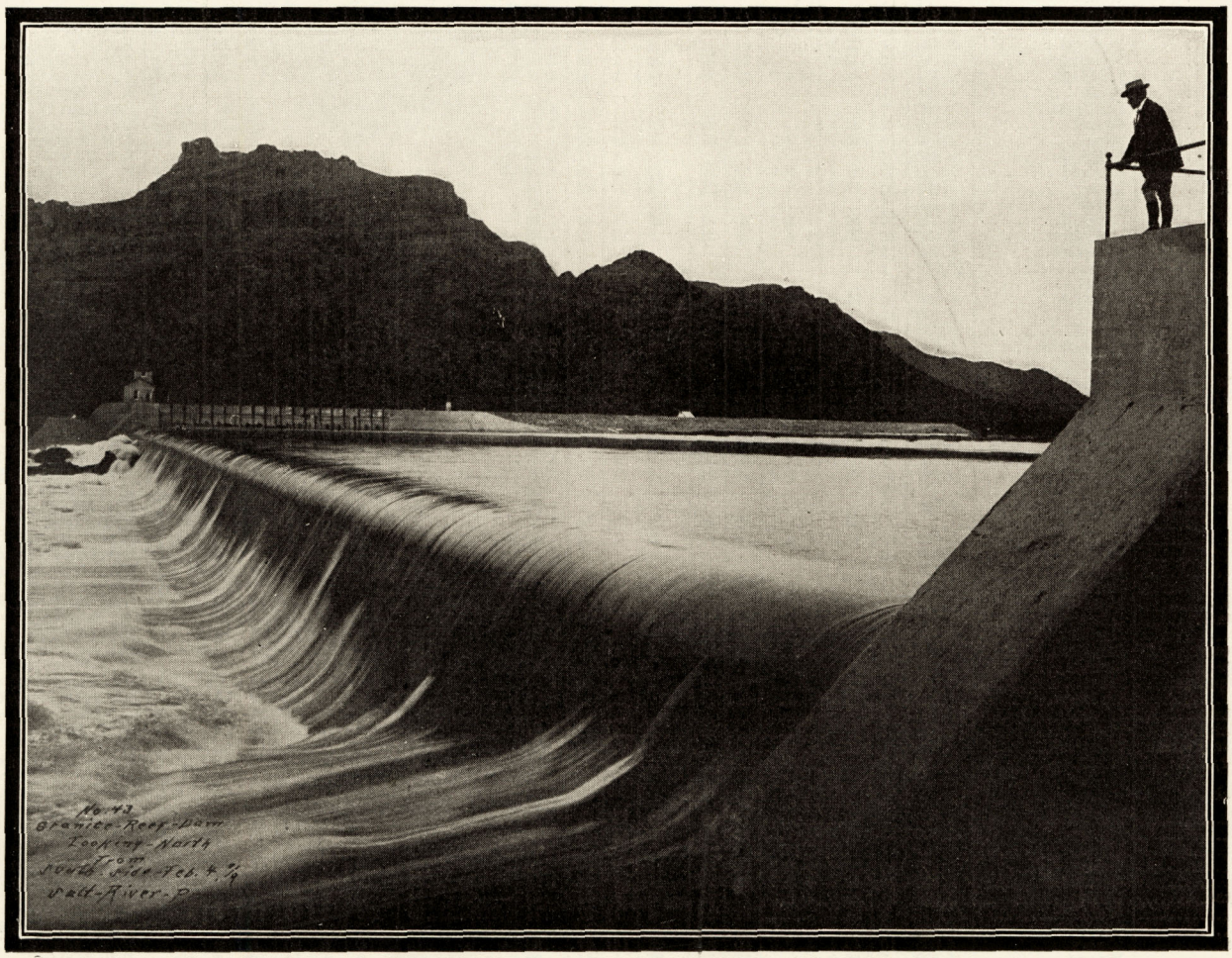

FIG. 2.—Flood Waters, Granite Reef Dam.